

thought, tended to show that the great difficulty of bony union in some fractures, such as intracapsular fracture of the neck of the femur, fracture of the patella, &c., was not so much due to any other peculiarity in the structure of the parts engaged in those fractures as the sparing supply of blood they are furnished with. Mr. Williams said that Dr. Houston had examined a section of the callus from this case with the microscope, and the detached islets of bone in the yellowish opalescent cartilage were quite obvious.—*Dublin Medical Press*, April 17th, 1844.

At a subsequent meeting of the society, (April 13,) Dr. Houston described the appearances which he had observed in a microscopic examination of a piece of callus from this patient. A section of this callus looked, to the naked eye, like a piece of cartilage—bluish, homogeneous, and compact; but when dried and examined with the microscope, it exhibited in every part innumerable points of ossification—some, isolated and distinct; others, agglomerated in heaps—the whole being evidently in a stage of transition from cartilage to bone. A similar condition Dr. Houston presumed would have been found in his case at a certain parallel stage of its progress towards reparation. Here, most probably, as the result of the irritation of the setons in the ossifying atmosphere of the bone, there had been, in the first place, an effusion of plastic lymph or jelly; then a conversion of this material into an organized bed of cartilage; and finally, an accumulation of osseous matter in the cartilage, at first in the form of minute isolated points, but in time, in such abundance as to repair the lesion and make firm the bones. Acting on the presumption that about the third week was the period at which, if at all, the cartilaginous bed had been formed, and the process of laying down the bone had commenced, he had chosen that time for the removal of the setons; and he had withdrawn them, thread by thread, with a view of guarding against the extremes, either of too great irritation, or of a premature cessation of the reparative action, one or other of which would have been likely to have attended on a forcible and sudden removal of all, at the same moment. He had thought it right, too, not to leave the setons between the bones for a longer period than three weeks, lest a morbid rather than a sanatory action might be set up by the too long-continued presence of the foreign bodies.—*Ibid.*, May 1, 1844.

37. *Reproduction of Bone in Necrosis.* Professor SYME exhibited to the *Med. Chirurg. Society*, Edinburgh, on the 3d of April last, some specimens to show that new bone was formed by the periosteum.

In the first place he produced specimens of the imperfect reproduction which occurs in cases where a portion of bone is removed by mechanical violence, as in the operation of trepanning the skull. The loss of substance here is not completely supplied, but only lessened, by a scanty growth of new bone round the margin of the aperture, diminishing in thickness from the circumference towards the centre, where there is usually a portion of the space occupied merely by a ligamentous membrane. He further illustrated this, by showing the result of experiments on dogs, performed in the way that Sir A. Cooper suggested, by removing a part of the radius, while the ulna was left entire. Here, too, the vacancy is very imperfectly provided with a substitute, by a conical shaped process of new bone from each extremity of the old one, extending from the cut surfaces of the breach, and tapering towards each other, so as to leave a deficiency, occupied by a ligamentous texture. He next showed a similar result from disease in the human subject, nearly the whole shaft of the tibia having died and been discharged without the formation of a successor, the appearance presented being precisely like that of the dog's bone just alluded to, and the imperfection of the limb so great as to require amputation several years after cicatrization of the sores. He then contrasted this preparation with one of necrosis in its ordinary form, where the old bone lies surrounded by a new shell ready to take its place in the event of removal. It is obvious, that this effectual reproduction cannot proceed from the remaining old bone, since it should in that case never be wanting, as there is always part of the shaft left entire, while it

had been found, that the bone possesses in itself very limited power of reproduction. The ample investing shell in question, therefore, not being attributable to the injury of the bone that retains its vitality, must be referred, 1. To separation and thickening of a lamina separated from the bone previous to its death. 2. To the ossification of organizable substance effused from the bone previous to its death. 3. To ossification of the periosteum. 4. To ossification of the neighbouring textures, whatever they may be. The arguments in support of these explanations being very plausible, it has always been considered most desirable to ascertain the truth, by examining the process which usually takes place. But where patients require amputation for necrosis, or sink under it, the disease is almost always either so recent or so far advanced, that the source of ossification cannot be recognized with certainty. In the course of fifteen years' hospital practice, Mr. Syme has met with only three cases that afforded an opportunity of dissection at the instructive period of formation, *i. e.*, from three to six weeks after the commencement of the disease. Simple inspection of the preparations so obtained seems sufficient to satisfy all eyes not obscured by preconceived opinions, that the new bone was formed on the inner surface of the periosteum. The osseous substance was deposited in crusts of uniform thickness, which implied an equality of reproductive action on the surface. The subjacent dead bone was perfectly smooth, which it could not have been if a lamina, however thin, had been detached from it. The periosteum was distinctly traced out and preserved, except at those parts where it had been destroyed by the disease; and it would have constituted the *clauæ* or defective portions of the osseous shell. In the early stage of the process the new bone was distinctly deposited in separate masses, which were plainly seen to be insulated from each other when surveyed between the eye and a light.

Dr. Henderson differed from Mr. Syme, and expressed his belief that the periosteum performed, in the process of the regeneration of bone, whether in necrosis or in fractures, only a secondary part—that it transmitted vessels into the organizable matter, which eventually exhibited the characters of bone, but that it did not possess the power of yielding directly a plastic exudation capable of undergoing development into cartilage and bone. He adverted to the investigations of Miescher on the generation of callus, as proving that it was yielded by the old bone only, and observed that the whole scope of the evidence afforded by the anatomy and physiology of bone and periosteum, tended to establish the doctrine, that the periosteum, though necessary indirectly to the growth and nutrition of bone, by affording it a supply of arterial twigs, is incapable of generating bone immediately from its own surface. Satisfied that such was the conclusion to which the formation of callus, and the generation and growth of bone, in the ordinary process of development, unequivocally pointed, he felt great difficulty in admitting that the specimens exhibited by Mr. Syme were calculated to show that the periosteum had an office conferred upon it, in the case of necrosis, which it possessed in no other circumstances. He conceived, that there was nothing in these specimens irreconcilable with the views he held on the functions of the periosteum; and he called attention to the circumstances, that where the new bone, in the specimens, was the thickest, it had an immediate connection with the old—that where detached scales of bone adhered to the periosteum alone, the dead bone over which they lay was in several places rough, intimating that a thin layer had been detached from it, and that where the scales which adhered to the periosteum corresponded to a smooth surface on the dead bone, it was extremely probable that they had originated from plastic matter, which had been thrown out by the inflamed bone, before the occurrence of necrosis. Bone, on becoming inflamed, did not die instantly, and the analogy of all other tissues in the state of inflammation seemed to render it certain that an organizable exudation may take place from the surface of an inflamed bone. These considerations induced Dr. Henderson to deny that the specimens brought before the society by Mr. Syme proved, or even rendered it probable, in the face of all the reasons that could be given for limiting the agency of the periosteum in the growth and reproductions of bone to the secondary rank, which he

had alluded to at the outset, that the periosteum could ever be the source of the new bone which is generated in necrosis.

Professor Miller stated, that he differed but slightly from Mr. Syme, as to the reproduction of bone in necrosis. His creed was very simple. In internal necrosis, of course, the work of reproduction is entirely effected by the surrounding bone. In external necrosis, he considered that the new formation of bone was of two parts, an internal and external, separated from each other by the sequestrum or dead portion in the first instance; but on the separation of this, coalescing and becoming consolidated to form an efficient substitute for the part destroyed. He believed that, in most cases, the doomed bone died very speedily, at least in its external surface, as indicated by its smooth unchanged appearance,—seeming as if a portion removed artificially from the skeleton. That at its circumference, the living bone speedily became universally vascular, and underwent the true inflammatory process; thereby establishing a sulcus of separation, by ulceration, precisely analogous to what takes place in detachment of a slough in the soft parts. That as this sulcus deepened, separation followed close upon ulceration; the depth being as yet altogether inconsiderable, when osseous nodules have begun to make their appearance on and around the living margin. This reparative effort on the surface of the old bone, almost coeval in its origin with that of the process of separation, he considered to be the starting point of the new structure, which thence proceeded in two layers; the *deep*, by what may be termed osseous granulation, following hard on the heel of ulceration in the separative sulcus, forming a continuous mass which occupies the place of what has been destroyed by the ulceration, and which, shooting upwards, assists in the extrusion of the dead part which the ulceration has fairly detached. At the same time a *superficial* layer, from the same origin, extends beneath the periosteum, and in close cohesion with it, apparently formed by that membrane; investing the dead portion on its external aspect, in a more or less continuous sheath of cortical formation—imperfect at certain points, where cloacæ are said to exist.

As to the formation of these cloacæ, he quite agreed with Mr. Syme, that they depended on deficiency of the periosteum. First, we have osteitis, then suppuration, and thereafter the full establishment of the necrosis. The matter collects in greater or less quantity beneath the periosteum, and sooner or later it must be discharged through that membrane, into the soft parts, and thence externally. If an incision be made, as it should be, that aperture in the membrane is permanent; for the acutely inflamed part does not heal, on the contrary, the chasm widens by ulceration. If incision be withheld, the perforation is by ulceration; the loss of substance is more extensive, and consequently more surely permanent. The advancing sheath of cortical bone coming to such an opening is interrupted, and there an aperture in it, termed cloaca, results, proportioned in form and extent to the deficiency of the membrane; for though other surrounding textures, as cellular or muscular, seem to have the power of assuming both the periosteal appearance and function, it is only when they are non-inflamed and capable of emplastix exudation; which in this case they are not, but, on the contrary, inflamed and suppurating, forming part of the canal through which the general purulent secretion is being discharged. In the formation of provisional callus, after simple fracture, he believed that ossification of the plasma was begun by the parent bone, taken up by the periosteum, and continued by the adjacent soft parts at the central or other parts of the periphery, where that membrane might happen to be deficient; and that these other adjacent textures were capable of the assumption of that function, because they were undergoing a grade of the inflammatory process short of suppuration, and favourable to the effusion and nutrition of an efficient plasma.

In death of the entire thickness of a bone, he believed that reproduction took place in a similar manner. That the deep portion shot forth from the truncated extremities of the old bone, assisting by its growth to dislodge the sequestrum; that the external or cortical layer was begun by the old bone, but mainly constructed by the periosteum; that, as usual, on extrusion of the dead portion,

the two new formations coalesced to form the substitute; and that when the death had proved so extensive as to render complete development of what might be termed the *heart* or *pith* of the new formation impossible, reproduction did not occur satisfactorily, if at all,—the cortical portion, when alone and unsupported, being unequal to this end.

Consequently, he believed, that in the reproduction of bone, in general, three textures might be employed. Bone formed bone better and more readily than did any other texture; periosteum was second only to bone, and superior to all other textures in this respect; other soft parts contiguous to periosteum, might supply that membrane's deficiency by assuming both its appearance and function, but only when these other soft parts were themselves not truly inflamed.

This creed he found applicable to all the surgical examples of osseous formation—as in ulcer of bone, fracture, necrosis, change on end of bone after amputation, &c. and capable of satisfactorily explaining all the phenomena attendant thereon.

Mr. Syme had adduced the reparation of deficiency in the cranium as a fact in favour of his argument, that periosteum is the main agent in reproducing bone. Professor Miller thought it had a precisely opposite bearing. The reparation was at first membranous: but after many years the aperture became closed by shelving bone gradually extending from the margins of the old, and evidently the product of that texture alone. Now, frequently, in the operation of trephining, the periosteum was not destroyed, but simply elevated with the rest of the flaps, and afterwards reopened; it was there consequently to secrete bone, if it chose; and, at all events, the dura mater was probably undisturbed, at least an equally efficient and quite analogous membrane; a better membrane, in fact; for a portion of the calvarium deprived of its periosteum by even rude violence, does not necessarily exfoliate, whereas a detachment of the dura mater is almost uniformly followed by necrosis of the corresponding portion of bone. Yet in the repair of a solution of continuity in the calvarium, we seldom if ever find the formation of cortical substitute; all osseous reproduction, in this instance, is from the parent bone alone; neither periosteum nor dura mater partaking in the effort.

Professor Miller also directed the attention of the Society to the *osteophyte* formations, found in the calvaria of women who have died recently after parturition—quoting from a review of M. Ducrest's paper on that subject, in the March number of Dr. Cormack's Journal. The prominent characteristic of this affection was that the new osseous formation was intimately incorporated with the internal surface of the skull, and could scarcely be separated from it, while the dura mater was non-adherent, and but little changed from its normal appearance,—a fact which also told against the idea of the periosteum possessing a superior power of osseous formation.

He begged to repeat, that he believed the periosteum had the power of forming new bone, in an eminent degree; but that in this respect it was altogether secondary to the parent bone. That practically, it mattered not whether the periosteum effused the plasma, as well as superintended its organization and transition into bone, as maintained by Professor Syme; or whether it only nourished a plasma which had been furnished to it by the old bone previous to its death, as maintained by Professor Henderson. And he trusted the society would remember that however the disputants might differ in the minor details, yet on the important and practical point they were all agreed; namely, that the presence of periosteum is *essential* to the formation of the cortical substitute; and that, consequently, in the treatment of necrosis, we ought to have our attention much directed towards ensuring the integrity of this membrane, by early evacuation of pus, and other means calculated to subdue and limit intense and destructive inflammatory action.

Dr. Bennett remarked, that so long as pathologists adopted an exclusive view regarding the production of bone from any particular tissue, so long would there be continual dispute. Selected preparations might be brought forward to support any theory advanced. Modern researches had demonstrated that new bone following fracture or necrosis was formed exactly in the same manner as bone

originally produced in the fœtus. Blood plasma was poured out in the neighbourhood of the injury, which was first transformed into cartilage, and then into bone. The essential part of the process was the exudation of healthy blood plasma, capable of being converted into osseous structure; the particular tissue or vessels which furnished it was a matter of secondary importance. The exudation might be furnished in one case from bone, in another from periosteum, or the surrounding tissues, and in a third, from all of them. Dr. B. considered that each of the views which had been contended for was true to a certain extent, but incorrect, in as far as they were exclusive in their nature.—*Lond. and Edin. Monthly Journ. Med. Sci.*, May, 1844.

38. *Necrosis*. Dr. J. A. LAWRIE relates in the London and Edinburgh Monthly Journal of Medical Science, (August 1843,) four cases of necrosis from which he deduces the following practical and physiological inferences.

"In the treatment of extensive necrosis, two practical difficulties present themselves;—first, in supporting the constitution, and preventing hectic; and, second, in the very tedious process of production of new bone, and the ultimate cure, by discharge of the dead portion. The latter is known to consist in the deposit of new bone, around the old and dead bone, encasing it, and subjecting it to the very doubtful process of absorption, or of separation and escape through the cloacæ in the new bone, and the ulcers in the soft parts. This process is so tedious as sometimes to occupy a lifetime, or to subject the patient to the very painful and uncertain operation of removing the dead bone, or even amputating the limb. So far as I know, no efficient means of meeting and overcoming these difficulties have yet been proposed. The two cases which I have related, show that in certain cases, and these the most severe, they may be obviated by the early removal of the dead bone, before it is encased or entangled in new bone. In neither of the cases was any incision required; in the first, on account of the extensive exposure of the bone; and, in the second, from its being broken, and its extremity projecting through an opening in the soft parts. We cannot, however, expect to find all our cases so favourably circumstanced. In some, the first steps will consist in exposure of the dead bone, by extensive incisions; and the second, in removing the dead bone by the saw and forceps. I have, at present, a case of necrosis of the tibia, under treatment, in which these steps will require to be put in practice.* The advantages of the operation are too numerous and obvious to require to be detailed.

"The physiological inferences which may be drawn from these cases, to my mind decide the question, as to the source from which bones are repaired, or regenerated after necrosis. The opinions on this subject were long divided between the periosteum and soft parts on the one hand, and the bone on the other. That bone, or at all events, calcareous matter, may be deposited in almost any organ or membrane of the body, is too well ascertained to make it improbable, that the same substance may be formed by the soft parts in the neighbourhood of bone, or by the periosteum, whose peculiar functions are to envelope and invigorate bone. That periosteum can form bone I well know, having seen bone deposited on both its surfaces, and into its substance, in considerable quantity. But it is one thing to admit that the vessels of periosteum may secrete or deposit spiculæ of bone, and another, to subscribe to the doctrine that this membrane is the efficient agent in the production of the mass of ossific matter, necessary for the reunion of broken bones, or the reproduction of an entire bone with the exception of the epiphysis. Both of these processes I have long been convinced are performed by bone, and can only be effected through its agency. It is not my intention to speak of the union of fractures,—that subject not being at present under consideration. I shall therefore limit myself to the second,—reproduction of new bone after necrosis; and in the first place, it is worthy of remark, that those bones which have epiphyses are much more certainly and rapidly regenerated after necrosis, than the flat bones, and those

* Since this paper was written, the case has been operated on, and with complete success.